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PATENT SPECIFICATION (11) 1 446 071

(21) Application No. 18561/73 (22) Filed 17 April 1973
(31) Convention Application No. 4941/72 (32) Filed 17 April 1972 in (19)
(33) Sweden (SW)
(44) Complete Specification published 11 Aug. 1976
(51) INT CL² F23B 1/14 F23H 7/08
(52) Index at acceptance
F4B 14C1 14D1 18B 4B A25J A25M

(54) FURNACES FOR SOLID FUEL

(71) I, CARL OSCAR ALEXANDER EKMAN, a Swedish subject of 19, Agnevagen, S 182 64 Djursholm, Sweden, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to furnaces for burning solid fuels, such as bituminous coals, smokelessly, and is concerned with improvements in and modifications of the invention forming the subject of my Patent No. 1,227,764, the specification of which describes and claims a furnace for burning solid fuels having a gas content, comprising a grate, a fuel inlet shaft which communicates only at the inner end with a combustion chamber above the grate by means of a restricted opening beneath a solid transverse wall, the lower end portion of the fuel inlet shaft forming a degassing chamber and a gas duct for conveying gas from the degassing chamber for distribution beneath a rearward section of the grate, wherein the bottom end of the degassing chamber portion of the inlet shaft is closed. Such a furnace will hereinafter be referred to as a furnace of the type defined.

In accordance with the present invention, there is provided a furnace of the kind defined in which the rear wall of the fuel inlet shaft, that is to say the wall nearer the fire bed on the grate, is inclined downwardly and rearwardly at a sufficient angle to the vertical to permit coal descending in the inlet shaft to swell under the action of heat. With this arrangement, the dead-plate or other means effectively closing the bottom end of the inlet shaft may not extend fully to the rear of the lowermost end of the inlet shaft. For example, the rear edge of the dead-plate may lie vertically below the rear edge of the entry to the inlet shaft.

An embodiment of the various aspects of the invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal sectional elevation of a coal-burning furnace;

Figure 2 is a vertical section on the line II—II of Figure 1;

Figure 3 is a composite horizontal section on the line III—III of Figure 2, and

Figures 4 and 5 show a detail of a modified grate driving arrangement in vertical section, in a plan view respectively.

The furnace shown in Figures 1 to 3 of the drawings is fundamentally similar in construction and operation to that described and illustrated in Patent Specification No. 1,227,764. Coal is fed to the furnace by a rotary feeding device 10 and descends under gravity down a coal inlet shaft 11. At the bottom of the shaft 11 is a dead-plate 12 which extends over the width of a forward extension of a substantially horizontal grate 13 between side-walls 14 of the furnace.

The front wall of the coal inlet shaft 11 is formed by a nearly vertical coal guide 15 while the rear wall 16*a* of the inlet shaft is formed by the front wall of a transverse refractory arch block 16 disposed above the grate 13 so as to define a restricted opening 17 connecting the coal inlet shaft 11 with a combustion chamber 18 situated beneath a top refractory arch formed by a plate 19. The rear edge 12*a* of the dead-plate 12 lies almost immediately below the top forward edge 16*b* of the arch block 16.

The space beneath the grate 13 is divided by transverse partitions 20 and 21 into an air inlet chamber 22 and a gas distributing chamber 23. All the air required for combustion enters the furnace through a louvred opening 24 in the front casing of the furnace. Natural chimney draught, forced draught or induced draught may be employed as desired.

The fuel on the grate 13 forms a burning fuel bed 25 which slopes away from the restricted opening beneath the arch 16 to the rear end of the grate 13 where the ash and any clinker which may have formed drop onto an ash-removing screw-conveyor 26.

The grate 13 is formed by a plurality of reciprocable parallel grate bars 27 having three sets of laterally projecting abutments, namely: abutments 28 at their forward ends, abutments 29 at their rear ends, and abutments 28 at an intermediate region above the transverse partition 20. The abutments 28, 29 and 30 on each bar 27 abut the corresponding abutments on the adjacent bars so that the portions of each grate bar 27 between the abutments 28 and 30 and between the abutments 30 and 29 are spaced from the corresponding portions of the adjacent bars. In this manner, a primary airflow channel 31 is formed between the air inlet chamber 22 and the fuel bed 25. Similarly, a secondary gas flow channel 32 is formed between the gas-distributing chamber 23 and the rear end of the fuel bed 25.

All the grate bars 27 are slidably supported at their forward ends on a transverse bar 34 and at their rear ends by the top of the rear wall partition 21 of the gas-distributing chamber 23.

The coal guide 15 forms a boundary between the coal inlet shaft 11 and a gas receiving chamber 35 at the front of the furnace. The lower part of the coal inlet shaft 11 communicates with the gas-receiving chamber 35 through an opening or openings 36.

The gas-receiving chamber 35 is connected to the gas distribution chamber 23 beneath the grate 13 by gas ducts 38 and 39 on either side of the furnace. As shown in Figure 1, the partition 20 is hollow and formed with openings 41 which can be arranged to give the emerging gas the required even distribution over the width of the burning fuel bed. The openings in the partition 20 have sloping surfaces 20' to deflect ash and riddlings from entering the gas duct 39. The gas entry to the gas duct 39 is shown at 40 in Figure 1.

A reciprocating mechanism for the grate bars 27 comprises a rotationally driven shaft 42 carrying radial arms 43, one for each grate bar. Each grate bar has a cam surface 44 engaged by a roller carried by the corresponding radial arm 43. The radial arms 43 are divided alternately into two angular spaced groups shown in Figure 1. As the shaft 42 rotates in the clockwise direction (Figure 1), one group of corresponding grate bars is retracted to the forward end position before the other group. However, a crossbar interconnecting the two outermost grate bars ensures that all the grate bars are then returned to the rear position shown in Figure 1 simultaneously, as a result of engagement of the crossbar with the abutments on the grate bars.

The top surface of the grate bars may slope as shown at 48. The relative movement between adjacent guide bars will then cause the top surface of the grate to undulate, thereby opening up the fuel-bed and discouraging the formation of clinker.

To assist in feeding the fuel to the grate, a reciprocating pusher bar 52 projects rearwardly over the dead-plate 12 with a running clearance forming effectively a seal between the pusher bar and the lower edge of the bottom of the gas-receiving chamber 35. The pusher bar 52 is bolted to the two outermost grate bars for movement with them.

The rotary fuel-feeding device 10 comprises a rotary feed member 61 in the form of a hollow cylinder having a portion of its wall cut away at 62. The cylinder 61 is secured to end discs 63 mounted on stub shafts 64 one of which is driven by a chain drive enclosed in a casing 65. The rotary feed member thus formed rotates within a casing 66 which includes an inlet chute 67 which is supplied with coal by a hopper (not shown). As can be seen in Figure 1, the rotary feed member rotates very close to the lower end of the chute 67 and thus when in the position shown in Figure 1 effectively closes off the chute 67, thereby preventing coal from entering the inlet shaft 11 and also forming a seal against the passage of significant amounts of air into or out of the shaft 11. As the rotary feed member rotates, the opening 62 comes into register with the lower end of the chute 67 and the interior of the rotary member is then filled with a charge of coal. In this position, the cylindrical wall 61 still acts to seal the entry to the shaft 11 against the passage of significant amounts of air. Thus, the wall 61 of the rotary feed member will prevent the propagation of a flame back from the furnace up the chute 67 to the coal supply hopper in the event that the driving mechanism for the rotary feed device 10 should fall for example due to an interruption in power supply. Further, it prevents any significant amount of additional air entering the furnace through the chute 67 and thereby upsetting the desired air balance within the furnace.

In addition to the screw-type ash-removal conveyor 26, the ash-removal system of the furnace comprises a pair of ash-removing cylinders 71 each extending along the length of the air inlet chamber 22 and gas distributing chamber 223. Each cylinder 71 is formed with a quadrant-section ash pocket 72 extending along the respective lengths of the chambers 22 and 23. The cylinders 71 are mounted for rotation in thickened portions 74 of the furnace chamber casting, each of the thickened portions 74 having in each of the chambers 22 and 23 an upper slot 75 for receiving ash falling from the fire bed and a lower slot 76

for discharging ash into the screw conveyor 26 in the case of the gas distributing chamber 23 and directly into an ash pit 77 in the case of the air inlet chamber 22.

Each of the cylinders 71 is extended forwardly by a shaft carrying a gear 78 meshing with a gear 79 on the shaft 80 of the screw 26*a*. The shaft 80 is itself driven by bevel gearing 81, 82 by an electric motor (not shown) driving through a variable ratio reduction gearing 83 the output of which also drives the shaft 42 of the grate bar reciprocating mechanism and the chain drive 65 to the rotary fuel-feeding device 10.

As can be seen in Figure 2, the lateral edges 74' of the slots through the thickened portion 74 subtend at the axis of the cylinder 71 an angle which is not less than the angle subtended by the pocket 72 at this axis. Thus, at no time during the rotation of the cylinder 71 is there a direct free path for air or other gas between the chamber 22 or 23 and the ash pit 77 or conveyor 26 respectively.

In use, coal on the grate 13 is ignited by means of a gas jet from a pipe 85 and the electric motor drive is started up. The rotary feeding device 10 delivers coal to the inlet shaft 11 at a metered rate. As it descends the inlet shaft 11, this coal is heated and begins to swell and degas. The gases driven off from the coal are drawn, together with some air from the air inlet chamber 22, into the gas collecting chamber 35 and from there through the ducts 38 and 39 and outlet louvres 41 into the gas distributing chamber 23 beneath the grate 13. The gases then pass up through the grate and through the hottest part of the fire bed to be burned completely. The rear edge 12*a* of the dead-plate 12 and the lower edge of the wall 16*a* located a boundary zone 86 between green coal in the shaft 11 and burning coal on the grate 13.

To enable the furnace to be closed down from full output operating conditions to a condition in which the fuel bed on the grate is just burning, corresponding to idling operation, and to enable this to be done in a relatively short time, for example in a few minutes, a by-pass air inlet 91 is formed adjacent the arch 16 and is closed in normal operation of the furnace by a flap 92. The flap 92 may be resiliently urged to the open position by a spring bias but held closed under normal operating conditions by a solenoid energised from the same source of power as the electric motor driving the various furnace mechanisms. Thus, in the event of electrical power failure, the flap 92 would open automatically. At the same time, the inlet 24 is closed by a suitable linkage (not shown) connected to the solenoid and spring. Further, the solenoid could be interconnected with the control system for the furnace, for example a boiler control system, so as to allow the flap 92 to open if there is a sudden fall-off in heat demand, for example by a boiler when the installation connected thereto is closed down.

When the flap 92 opens, the inlet 91 supplies all the air required by the draught in the furnace. The heating effect on the green coal in the inlet shaft is then greatly reduced and combustion only takes place towards the rear of the fire bed.

The grate of the furnace shown in Figures 1 to 3 to 24" wide and 18" long, measured from the rear edge 12*a* of the dead-plate 12 to the rear free ends of the grate bars. The grate thus has a burning area of three square feet. With the camshaft 42 rotating at about 2 revolutions per minute, the furnace will burn about 200 lbs. per hour of coal, that is, at a rate of 70 lbs. per square foot per hour. Under these conditions, the furnace generates about 2,000,000 B.Th.U. per hour which is similar to that of an oil-burning furnace of comparable overall dimensions to those of the furnace shown in Figures 1 to 3 which can accordingly be installed in boilers designed for oil-burning without the need for appreciable modification of the boiler.

In the modification of the grate driving arrangement shown in Figure 4, the grate bars, 27A, 27B, do not have forward extensions carrying the cam surface 44. Instead, the grate bars in each group are interconnected by a crossbar. In the case of one group B, the crossbar is formed by the pusher 52B while in the case of the other group, A, (a portion of one of the bars of which is shown in Figure 4) the crossbar is formed by a bar 52a which is mounted with a running clearance between the grate bar support 34' and the lower edge of the pusher 52B, thus forming an effective seal to prevent air being drawn in to the furnace at this point. Each end of each crossbar 52A, 52B, carries a driving member 101A, 101B respectively. Each of the driving members 101 presents a cam surface 107 which performs the same function in relation to the rollers mounted on the camshaft (not shown) as the cam surfaces 44 in the embodiment shown in Figures 1 to 3.

Features of the ash removal arrangement described above form the subject of my copending application No. 49696/75 (Serial No. 1446072)

WHAT I CLAIM IS:—

1. A furnace of the kind defined in which the rear wall of the fuel inlet shaft, that is to say the wall nearer the fire bed on the grate, is inclined downwardly and rearwardly at a sufficient angle to the vertical to permit coal descending in the inlet shaft to swell under the action of heat.

2. A furnace according to claim 1, wherein the dead-plate or other means effectively closing the bottom end of the inlet shaft does not extend fully to the rear of the lowermost end of the inlet shaft.

3. A furnace according to claim 2, wherein the rear edge of the dead-plate lies vertically below the rear edge of the entry to the inlet shaft.

4. A furnace according to any of claims 1 to 3, wherein the grate bars of the grate are divided into groups with the bars of each group interconnected for simultaneous movement with, but interspersed with, the other bars, and driving cam surface portions for each group for cooperation with the driving cam shaft are formed on a separate member or members secured to the respective group.

5. A furnace according to any of the preceding claims wherein a normally closed damping air inlet above the grate can be opened to reduce rapidly the heat output of the furnace to an idling condition.

6. A furnace according to claim 5, wherein the normal air inlet to the furnace is arranged to be closed simultaneously with the opening of the damping air inlet.

7. A furnace according to claim 5 or 6, wherein the damping air inlet is in normal operation held closed by a solenoid against the action of resilient means capable of opening the damping air inlet when the solenoid is de-energized.

8. A furnace according to any of the preceding claims and including an arrangement for removing waste solid particulate material such as ash and riddlings from the furnace, the said arrangement comprising a rotary feed member mounted for rotation about its axis in an opening in a wall below the grate so as to carry to the material from one side of the wall to the other, the rotary feed member being formed with one or more feed pockets, the arrangement of the rotary feed member in relation to the edges of the opening being such that in all rotary positions of the feed member the latter substantially closes the said opening.

9. A furnace according to claim 8, wherein the angle subtended by each lateral edge of the opening at the axis of the rotary member is at least equal to the angle subtended at the said axis by the pocket or pockets.

10. A furnace according to claim 8 or 9 for ash removal from the furnace, wherein the rotary member is arranged to drop ash onto a mechanical conveyor, for removing ash from an ash pit beneath the fire bed.

11. A furnace according to claim 10, wherein the conveyor leads to the front of the furnace.

12. A furnace according to any of the preceding claims having an arrangement for feeding solid fuel into the inlet shaft, the arrangement including a rotary member mounted for rotation about an axis transverse to the passage, the rotary member having a pocket for receiving and transferring solid fuel from one side of the rotary member to the other as it rotates while substantially closing the passage in all rotary positions of the rotary member.

13. A furnace substantially as hereinbefore described with reference to Figures 1 to 3 or Figures 4 and 5 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1976.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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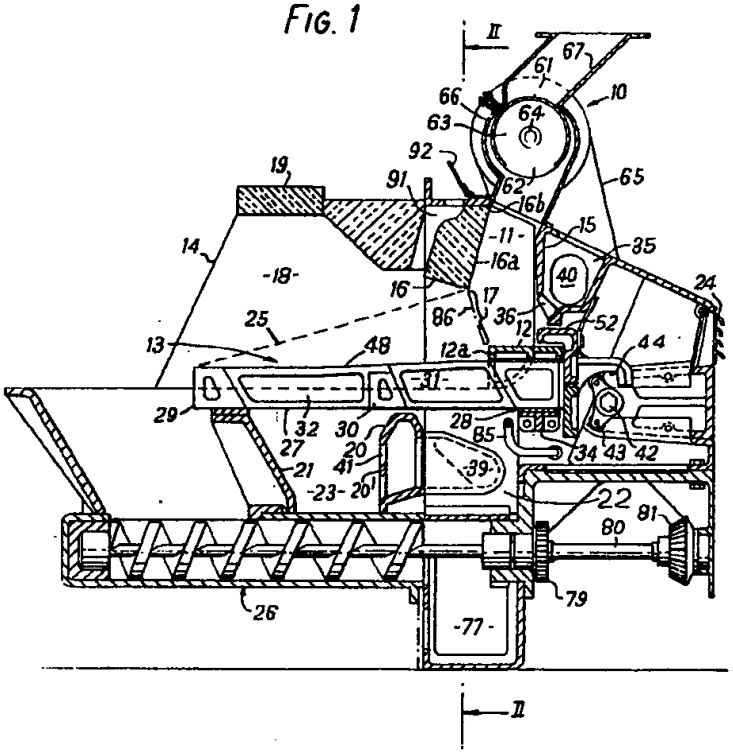
FIG. 1



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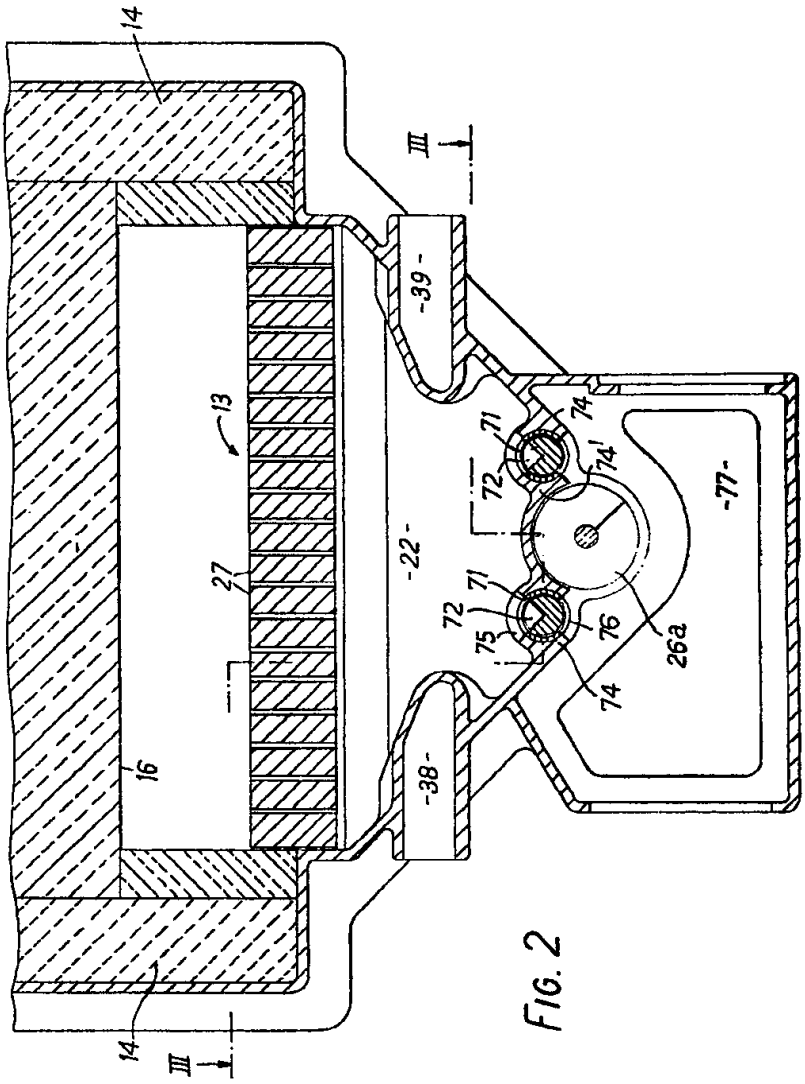

FIG. 2

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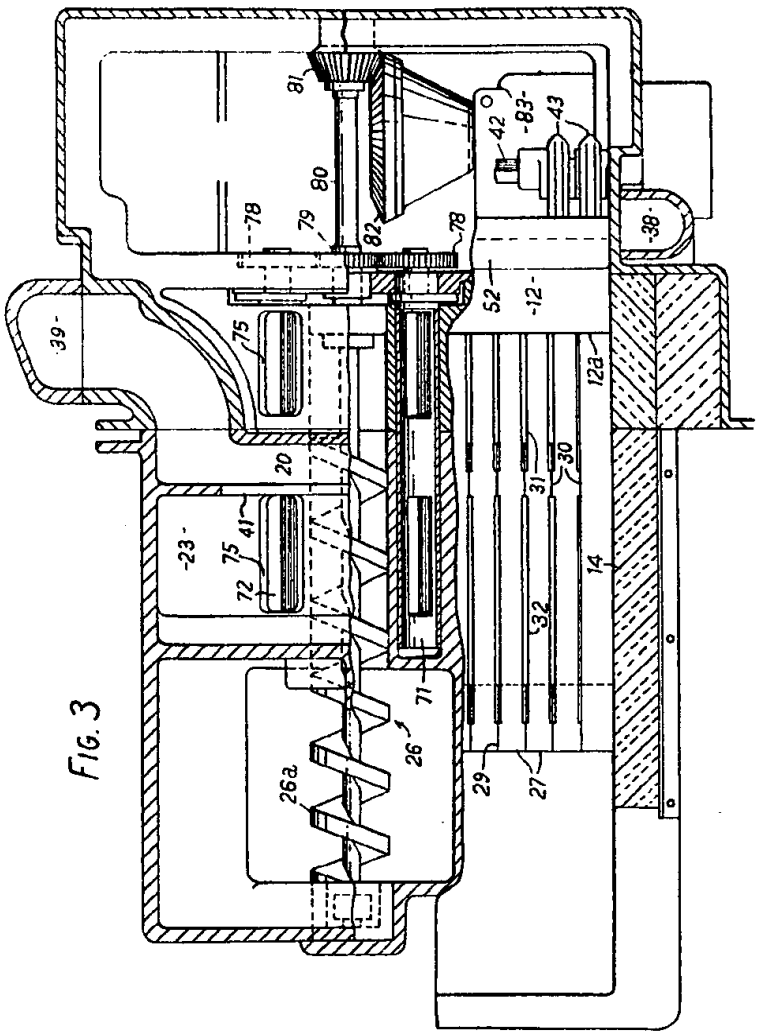
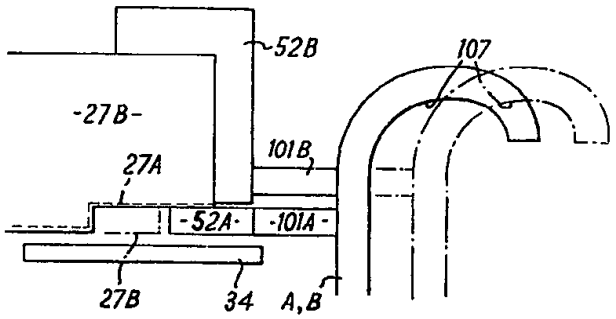


FIG. 3

FIG. 4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52A
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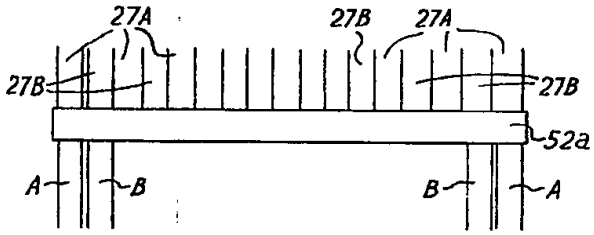
34
A,B

FIG. 5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27B
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